

Claims

1. A method of measuring an intrinsic resistance of a battery comprising the steps of:

measuring periodically a discharge current and a terminal
5 voltage responding to the discharge current at a low rate discharge of the battery;

determining a first approximate expression of the terminal voltage with respect to the increasing discharge current and a second approximate expression of the terminal voltage with
10 respect to the decreasing discharge current based on the measured discharge current and terminal voltage;

defining a range of the intrinsic resistance based on the first and second approximate expressions;

assuming a resistance in the range of the intrinsic
15 resistance as a tentative intrinsic resistance;

determining a tentative maximum polarization time from the second approximate expression and the tentative intrinsic resistance; and

determining the intrinsic resistance from two relational
20 expressions including the intrinsic resistance, an intrinsic maximum polarization time and the tentative maximum polarization time.

2. The method as claimed in claim 1, wherein said two
25 relational expressions comprise:

a first relational expression given by equating the

intrinsic resistance to a formula of $\{(a \text{ period of time between a start of discharge and the intrinsic maximum polarization time}) / (a \text{ period of time between the start of discharge and the tentative maximum polarization time})\} \times (a \text{ maximum value in the range of the intrinsic resistance}) + \{(a \text{ period of time between the intrinsic maximum polarization time and the tentative maximum polarization time}) / (the \text{ period of time between the start of discharge and the tentative maximum polarization time})\} \times (a \text{ minimum value in the range of the intrinsic resistance})$; and

a second relational expression given by equating the intrinsic resistance to a formula of a differential equation of the second approximate expression substituted the discharge current with a current of a formula of $(a \text{ peak current}) \times \{(the \text{ period of time between the intrinsic and tentative maximum polarization times}) / (a \text{ period of time between a peak current time and the tentative maximum polarization time})\}$.

3. The method as claimed in claim 1 or 2, further comprising the steps of:

differentiating the first approximate expression with respect to the discharge current to obtain a first amount of change;

differentiating the second approximate expression with respect to the discharge current to obtain a second amount of change; and

defining the range of the intrinsic resistance between (the first amount of change + the second amount of change) / 2 and (the second amount of change) at the peak current.

5 4. The method as claimed in any one of claims 1-3, wherein the center value of the range of the intrinsic resistance is the tentative intrinsic resistance.

10 5. An apparatus for measuring an intrinsic resistance of a battery comprising:

 a current sensor for measuring a discharge current of a battery at a low rate discharge;

 a voltage sensor for measuring a terminal voltage of the battery responding to the discharge current;

15 an interface circuit for converting the measured voltage from analog to digital; and

 a microcomputer having a CPU, a RAM and a ROM,
 wherein the CPU

20 receives data of the measured current and voltage from the interface circuit;

 calculates a first approximate expression of the terminal voltage with respect to the increasing discharge current and a second approximate expression of the terminal voltage with respect to the decreasing discharge current from the measured
25 discharge current and terminal voltage;

 defines a range of the intrinsic resistance from the first

and second approximate expressions;

assumes a resistance in the range of the intrinsic resistance as a tentative intrinsic resistance;

5 determines a tentative maximum polarization time from the second expression and the tentative intrinsic resistance; and

determines the intrinsic resistance from two relational expressions including the intrinsic resistance, an intrinsic maximum polarization time and the tentative maximum polarization time.

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